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Final Report

ENERGY SURVEY FOR R.W. BLISS ARMY COMMUNITY HOSPITAL AND DENTAL CLINIC FORT HUACHUCA, ARIZONA

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

EXECUTIVE SUMMARY

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S.0 INTRODUCTION

This document is the Executive Summary of the Energy Survey/Energy Engineering Analysis Program for the R.W. Bliss Army Community Hospital prepared under Contract No. DACA05-85-143 between the Department of the Army (Sacramento District), Corps of Engineers, and ANCO Engineers, Inc. This project has been executed as a part of the Department of the Army's Energy Engineering Analysis Program (EEAP). The overall objective of the project is to develop a systematic plan of projects that will result in the reduction of the energy consumption in compliance with the objectives set forth in the Army Facilities Energy Plan (AFEP), without decreasing the readiness posture of the Army.

The criteria utilized in performing this EEAP study is the Scope of Work (SOW) dated September 1984, revised April 1985, which includes the Detailed Scope of Work for R.W. Bliss Army Community Hospital. The complete Scope of Work is provided in Appendix M in the main body of this report. All energy conservation opportunities considered will be included in one of two categories, ECIP Projects or Non-ECIP Projects.

The governing criteria for ECIP projects and for performing economic analyses is the "Energy Conservation Investment Program (ECIP) Guidance," DAEN-MPO-U, 6 August 1982, revised 4 March 1985. The construction cost of ECIP projects must be greater than $200,000. It is assumed that all improvement projects will be awarded in FY 1988 (midpoint of construction in January of FY 1990, BOD in July of FY 1989). The Uniform Present Worth (UPW) discount factors utilized in the Savings to Investment Ratio (SIR) life-cycle cost economic analysis are taken directly from Table 9 of the ECIP Guidance. Table 9 UPW discount factors are based upon a 7% discount rate. The maximum possible economic life for all ECIP projects is 15 years.

This Executive Summary and all of the Programming Documents that result from this study fully comply with the criteria and guidance documents described above. As per the Site Specific Scope of Work, the Programming Documents generated by this EEAP include DD Form 1391, Life-Cycle Cost Analysis Summary Sheet and the Project Development Brochure, PDBI, for ECIP Projects.

The study methodology for the EEAP at R.W. Bliss Army Community Hospital was segmented into three phases of work. Phase I involved data

gathering and field surveys. Phase II included analysis of the data collected during the initial phase, identification of potential projects, feasibility and economic evaluations, and preparation of support data for DD Forms 1391. The procedure for identification of potential projects includes use of Annex A of the SOW, "Energy Conservation Opportunities." The final segment of the study methodology Phase III, included completion of the DD Forms 1391, and preparation of the final report document which presents the results, and recommendations of this study.

The Executive Summary specifically addresses results pertaining to the completion of all phases of the study. The Final Report consists of all of the data developed throughout the study, as well as all energy savings project developments and recommendations. The Final Report volume titles are delineated below for which this Executive Summary applies:

Volume I: Main Report
Volume II: Executive Summary
Volume III: Programming Documents

A brief description of the Hospital and Dental Clinic is presented next in this Executive Summary. Sections 2.0 and 3.0 discuss the energy profile of the hospital, including current energy use and current energy expenses. Section 4.0 presents a summary of the Energy Conservation Opportunities (ECOs) developed as a result of the EEAP. The packaged energy conservation projects analyzed and the economic feasibility results of these projects are reviewed in Section 5.0. The energy plan which addresses the projects implementation strategy and the effects on future hospital energy consumption is presented in Section 7.0

The results of the Energy Survey for the Energy Engineering Analysis Program for the R.W. Bliss Army Community Hospital and Dental Clinic, Fort Huachuca, Arizona, are summarized in the sections that follow.

S.1 FACILITY DESCRIPTION

The R.W. Bliss Army Community Hospital and Dental Clinic are located within the Fort Huachuca Army Post, near the city of Sierra Vista, 70 miles southeast of Tucson, Arizona. Figure S.1.1 shows the relative location of the Hospital and Dental Clinic with respect to the Post.

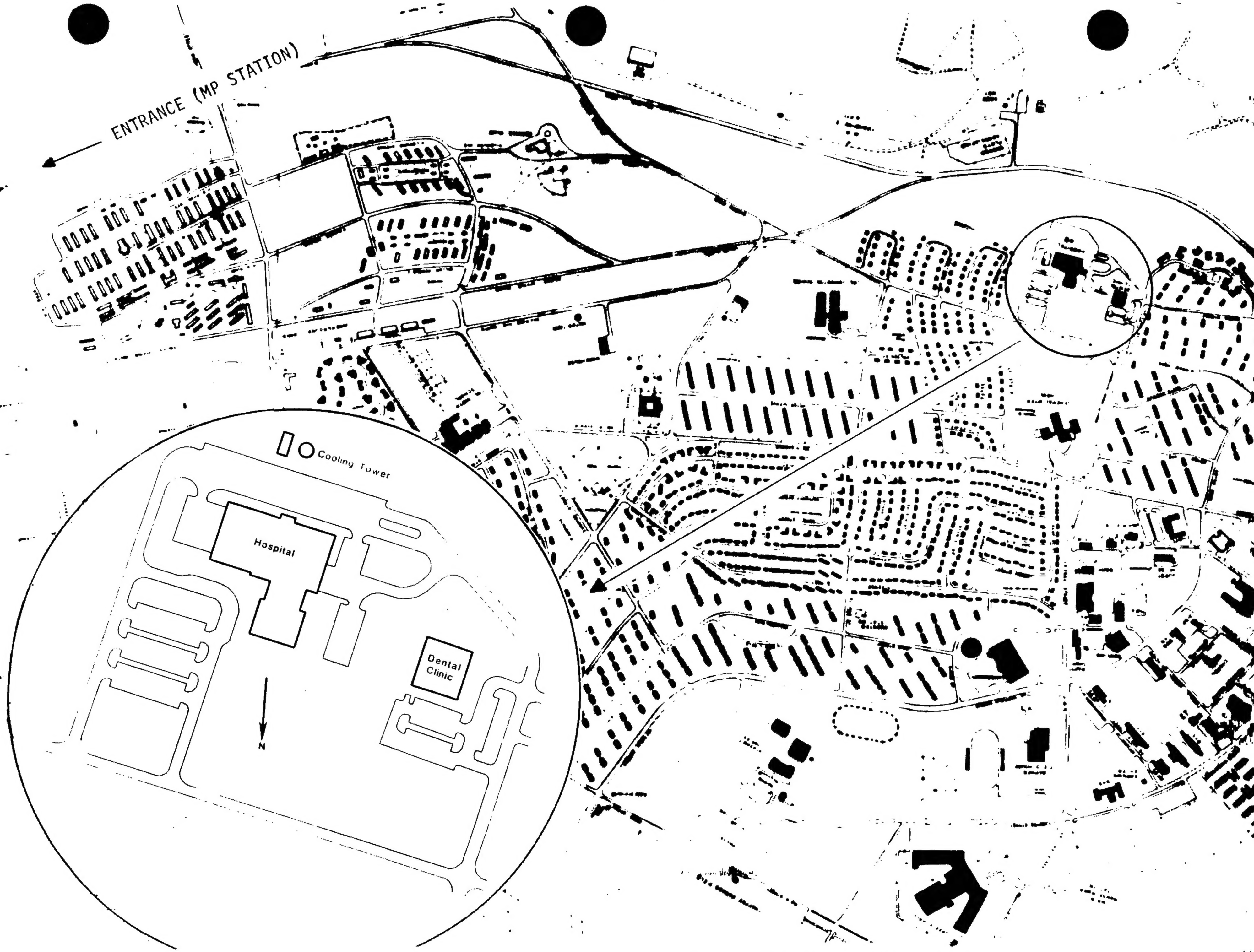

Figure S.1.1: LOCATIONS MAP FOR R.W. BLISS ARMY COMMUNITY HOSPITAL AND DENTAL CLINIC

The 74,975-sq-ft, 104-bed hospital was built in 1968, with the Dental Clinic added in 1978. Both buildings are primarily constructed with reinforced concrete, with single-glazed metal fram windows and doors.

A number of mechanical systems serve the hospital. The primary energy conversion equipment is housed in the boiler room. This includes two 200-hp steam boilers, two steam-to-hot-water heat exchangers, two hermetic centrifugal 130-ton chillers, energy transfer fluid circulating equipment, and an emergency electric power generating system.

Twelve separate air handling units serve the different areas in the hospital: eight multi-zone, dual-duct systems, and four single-zone, single-duct systems.

The Dental Clinic's heating, ventilation and cooling is currently provided by a dual-duct, 40-ton split air conditioning system. Heating hot water is provided by a 900 kBtu/hr gas-fired water heater.

The hospital domestic hot water is produced in two storage tanks located in the boiler room, using steam-to-hot-water heat exchangers.

The interior lighting of both the hospital and the dental clinic is provided by fluorescent, incandescent, mercury vapor, and high-pressure sodium lamps. The exterior lighting consists of a mercury-vapor wall and pole-mounted fixtures.

The hospital is currently connected to the post-wide Energy Monitoring and Control System (EMCS) located at Greely Hall for a limited range of monitoring and control functions. The Dental Clinic is not connected to the EMCS.

S.2 PRESENT ENERGY CONSUMPTION

Electricity is metered at the Fort Huachuca complex at a single meter, and, thus, the hospital and dental clinic do not have separate meters. In order to establish a baseline for comparison of actual energy use to simulated energy use, a Dranetz Series 808 power analyzer was installed at the electrical service entrance to the hospital. The power analyzer monitored and recorded daily and monthly electricity use in kWh, maximum demand in kW, and power factor for the months of October, November, and December. Natural

gas consumption at the hospital is metered at a single meter located in the boiler room. Several readings were taken from the meter as part of the audit procedure, and monthly natural gas use was estimated from this data. The results of this metering, as well as the results of the baseline DOE-2 simulation, are compiled in Table S.2.1 and compared graphically in Figures S.2.1 and S.2.2. Figure S.2.3 depicts the energy distribution by end use at the hospital as simulated by DOE-2. The discrepancies between metered and modelled energy use figures are due to the use of 20-year average weather data in the model. No attempt was made to monitor energy use at the dental clinic since it is not required by the SOW.

S.3 HISTORICAL ENERGY CONSUMPTION

There is no historical energy consumption data available for either the hospital or the dental clinic.

S.4 ENERGY CONSERVATION ANALYSIS

S.4.1 Energy Conservation Opportunities (ECOs) Investigated

All of the ECOs listed in Table S.4.1.1 of the detailed scope of work were examined for their potential implementation at the hospital and dental clinic. A complete item-by-item response to this list for the hospital is provided in Table 4.0.1 in the main report. While Table S.4.1.1 was reviewed for the purpose of identifying ECOs at the dental clinic, a similar item-by-item response listing is not included in this report.

S.4.2 ECOs Recommended

The following ECOs have been identified as cost effective and are recommended for implementation. For a more detailed discussion, see main body of this report: Section 4.0 for the hospital and Section 7.0 for the dental clinic.

S.4.3 R. W. Bliss Hospital

Heating, Ventilating, and Air Conditioning

- Reduce outside air volumes
- Convert existing constant-volume, dual-duct system to variable air volume

TABLE S.2.1: BASELINE SIMULATION AND ACTUAL ENERGY USE FOR THE R. W. BLISS HOSPITAL

	ACTUAL METERED				BASELINE SIMULATION			
MONTH	GAS (MBTU)	ELECT. (MWH)	TOTAL (MBTU)	DEMAND (KW)	GAS (MBTU)	ELECT. (MWH)	TOTAL (MBTU)	DEMAND (KW)
JAN					3456.9	222.6	4216.6	428.4
FEB					3424.4	200.5	4108.7	442.1
MAR					3176.8	229.0	3958.4	585.1
APR					3100.8	228.1	3879.3	484.0
MAY					2601.7	242.5	3429.4	499.9
JUN					1088.3	241.4	1912.3	504.8
JUL					456.3	245.8	1295.2	508.9
AUG					380.7	247.5	1225.4	505.7
SEP					863.2	230.9	1651.3	492.2
OCT	1721	256.1	1046	579.0	2042.3	228.5	2822.2	475.8
NOV	1982	389.0	1526	582.9	3056.3	217.5	3798.6	456.5
DEC	2143	407.2	1604	581.7	3710.1	222.7	4470.2	450.9
TOTAL					27357.8	2757.00	36767.5	

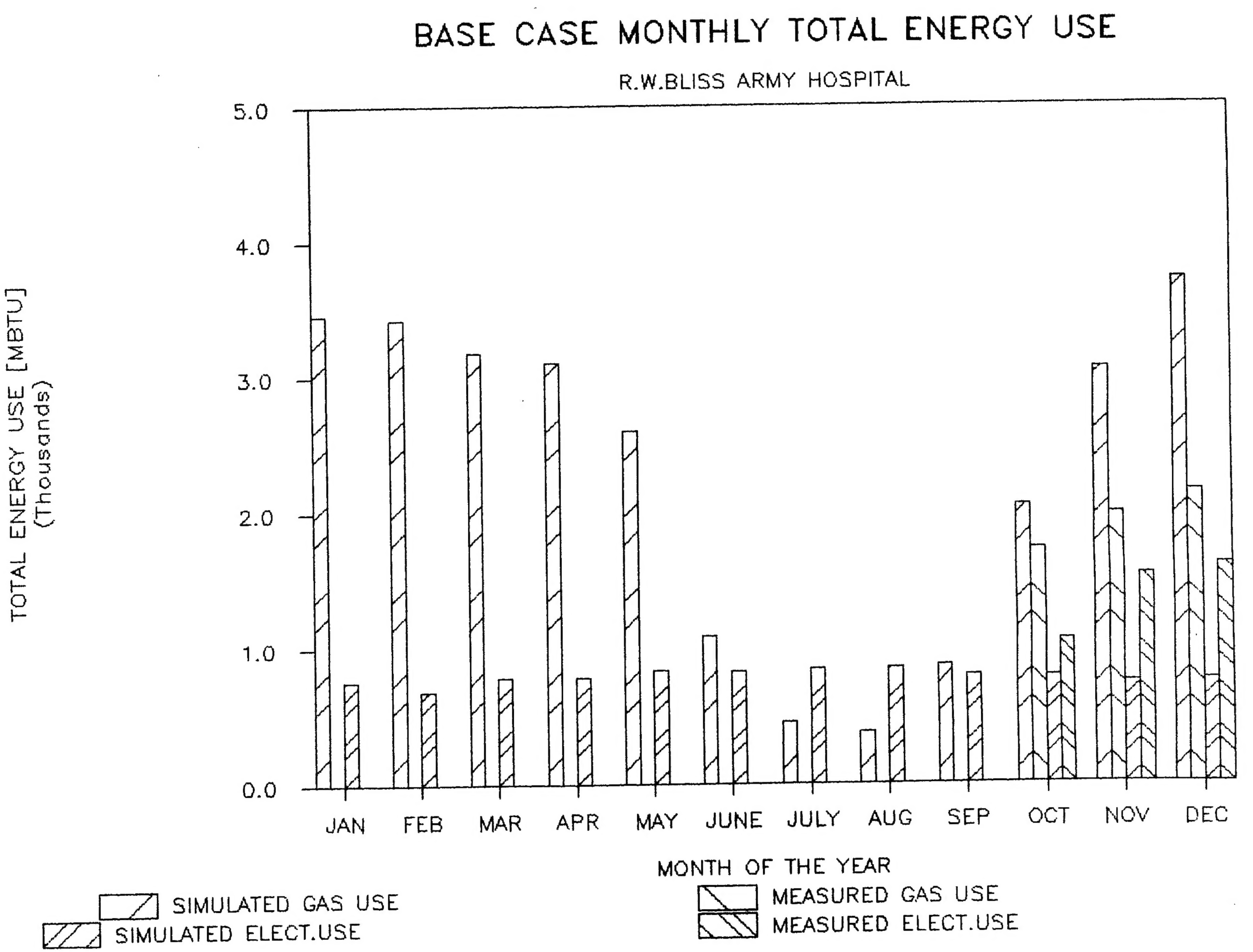
BASE CASE MONTHLY TOTAL ENERGY USE
R.W.BLISS ARMY HOSPITAL
TOTAL ENERGY USE [MBTU]
(Thousands)
5.0
4.0
3.0
2.0
1.0
0.0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
MONTH OF THE YEAR
SIMULATED GAS USE
SIMULATED ELECT.USE
MEASURED GAS USE
MEASURED ELECT.USE

Figure S.2.1

BASE CASE MONTHLY ELECTRIC DEMAND

R.W.BLISS ARMY HOSPITAL

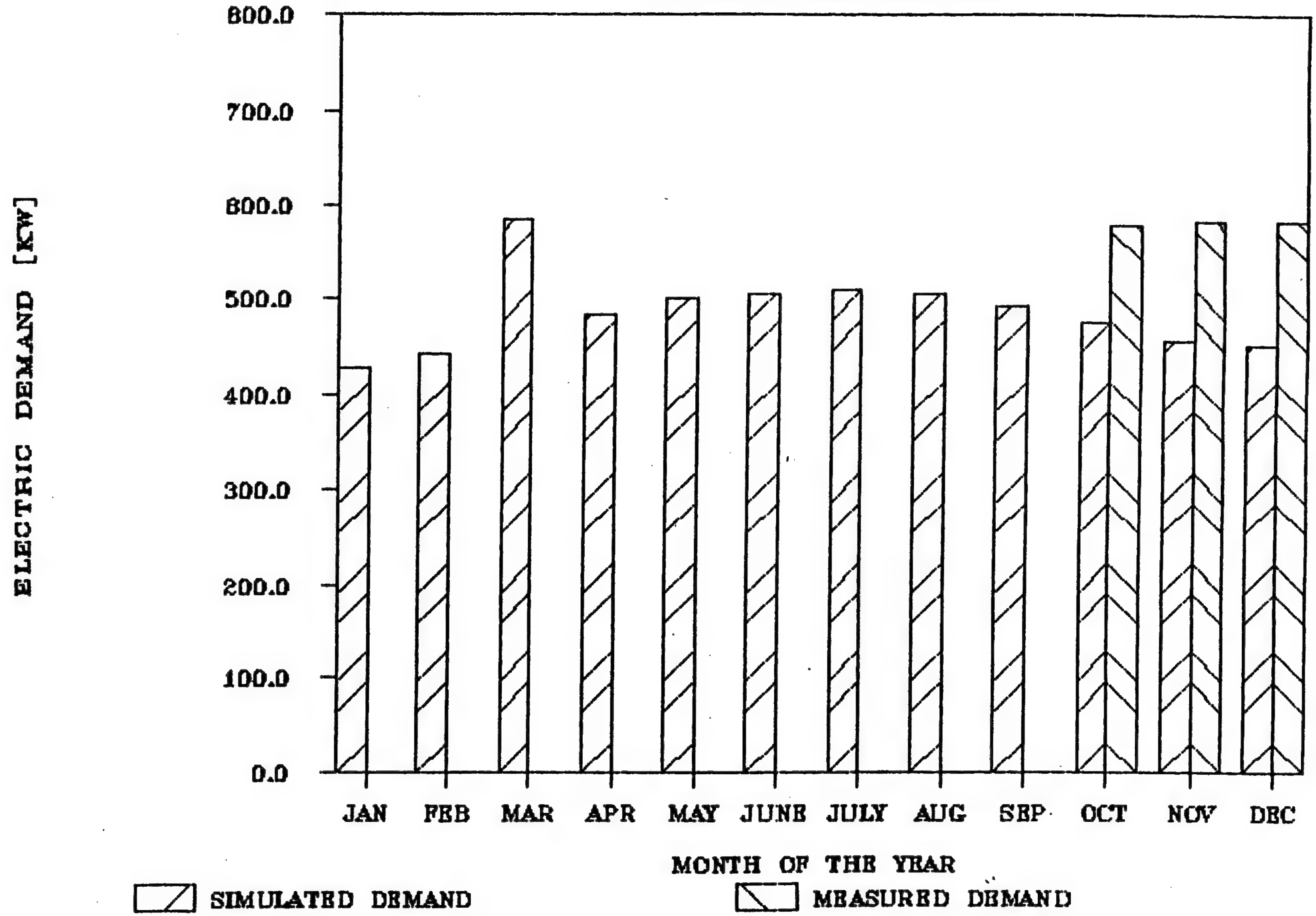

Figure S.2.2

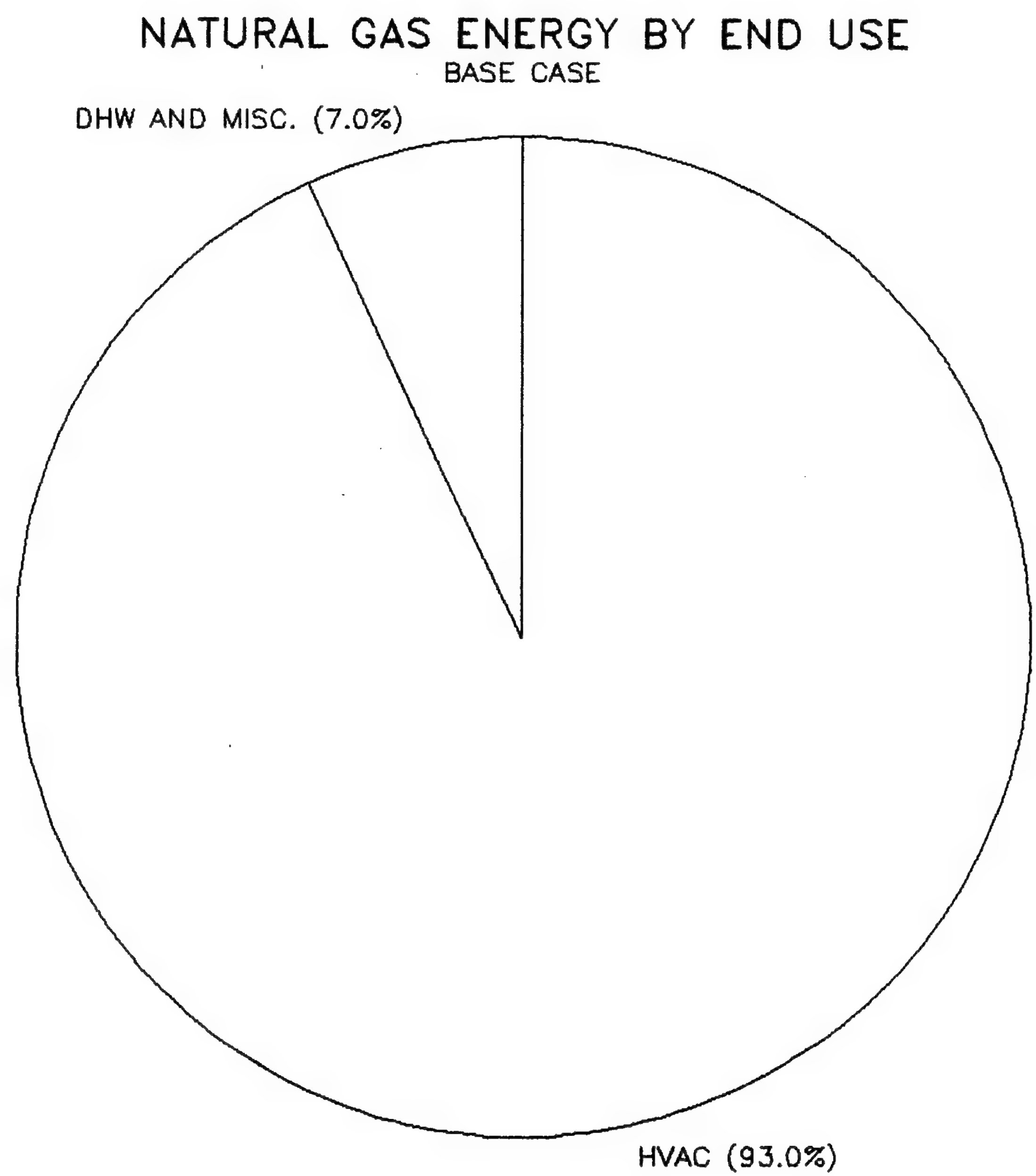
NATURAL GAS ENERGY BY END USE
BASE CASE
DHW AND MISC. (7.0%)
HVAC (93.0%)

Figure S.2.3

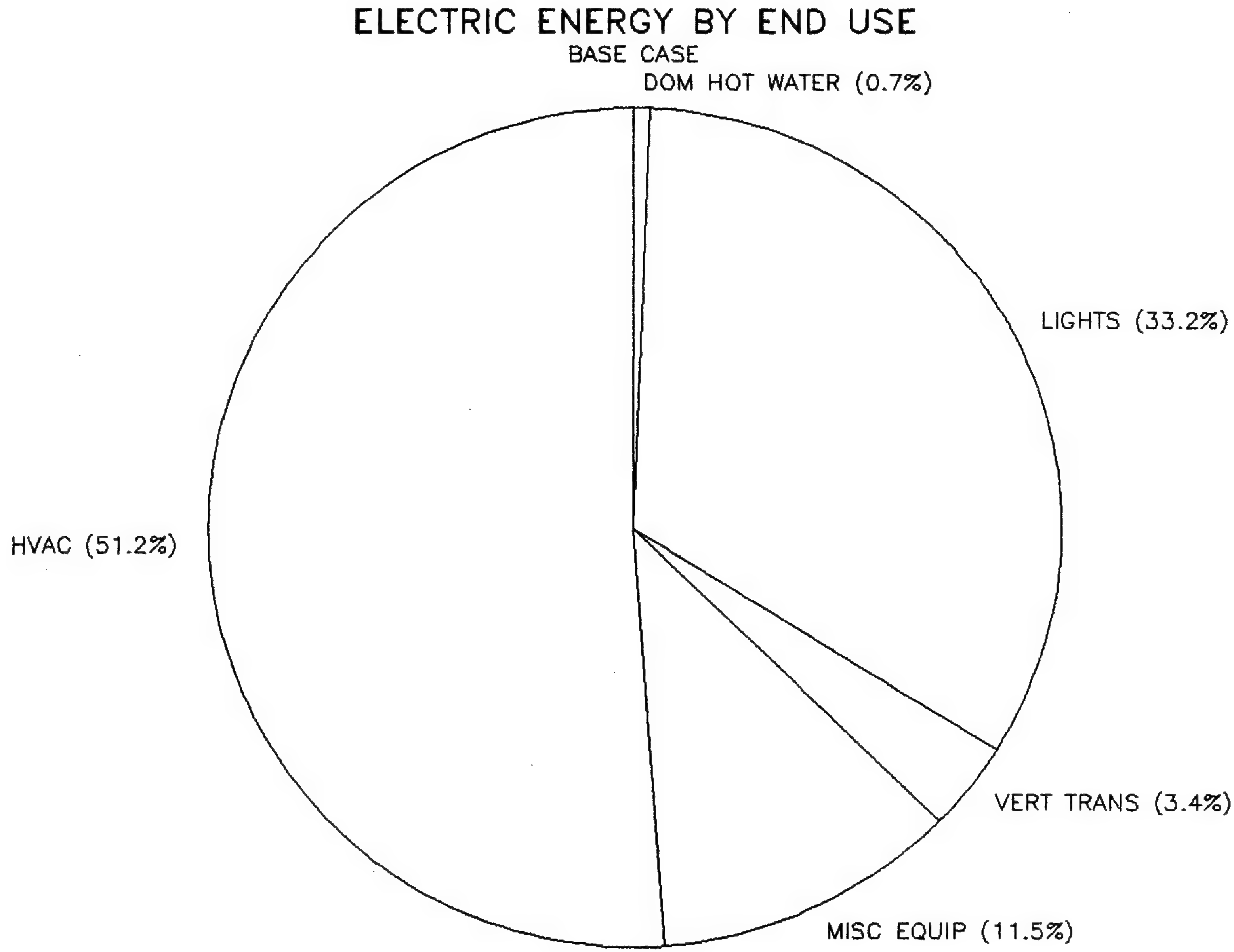

Figure S.2.3 (concluded)

TABLE S.4.1.1: ENERGY CONSERVATION OPPORTUNITIES (ECOs)

Heating, Ventilating, and Air Conditioning

1. Shut off air-handling units whenever possible.
2. Reduce outside air intake when air must be heated or cooled before use.
3. Reduce volume of air circulated through air-handling units.
4. Shut off or reduce speed of room fan coils.
5. Shut off or reduce stairwell heating.
6. Shut off unneeded circulating pumps.
7. Reduce humidification to minimum requirements.
8. Reduce condenser water temperature.
9. Cycle fans and pumps.
10. Reduce pumping flow.
11. Reset thermostats higher during cooling and lower during heating.
12. Repair and maintain stem lines and steam traps.
13. Use damper controls to shut off air to unoccupied areas.
14. Reset hot- and cold-deck temperatures based on areas with greatest need.
15. Raise chilled water temperature.
16. Shed loads during peak electrical use periods.
17. Use outside air for free cooling whenever possible.
18. Reduce reheating of cooled air.
19. Recover heating or cooling with energy recovery units.
20. Reduce chilled water circulated during light cooling loads.
21. Install minimum sized motor to meet loads.
22. Replace hand valves with automatic controls.
23. Install variable air volume controls.
24. Insulate ducts and piping.
25. Eliminate simultaneous heating and cooling.
26. Install night setback controls.
27. Clean coils.
28. Maintain filters.
29. Repair and/or maintain air-handling controls.
30. Multi-speed/variable-speed cooling tower fans.
31. Use centrifugal chillers instead of absorption chillers.
32. Chiller economizing cycle using cooling tower with heat exchangers in lieu of chiller.

Boiler Plant

1. Reduce steam distribution pressure.
2. Shut off steam to laundry when not in use.
3. Increase boiler efficiency.
4. Repair, replace, or install condensate return system.
5. Insulate boiler and boiler piping.
6. Install economizer.
7. Install air preheater.
8. Check boiler water chemistry program.
9. Clean boiler tubes.
10. Blowdown controls.
11. Boiler and chiller control modifications.
12. Common manifolding of chillers.
13. Water treatment to prevent tube fouling.

TABLE S.4.1.1 (continued)

Lighting

1. Shut off lights when not needed.
2. Reduce lighting levels.
3. Revise cleaning schedules.
4. Convert to energy-efficient systems.

Building Envelope

1. Reduce infiltration by caulking and weatherstripping.
2. Install storm windows or double-pane windows.
3. Install roof insulation.
4. Install loading dock seals.
5. Install vestibules on entrances.
6. Reduce window heat gain by solar shading, screening, curtains or blinds.
7. Install wall insulation.

Electrical Equipment

1. Shut off elevators whenever possible.
2. Shut off pneumatic tube system whenever possible.
3. Install capacitors or synchronous motors to increase power factor.
4. Use emergency generator to reduce peak demand.
5. Shed or cycle electrical loads to reduce peak demand.
6. Balance loads.
7. Reduce transformer losses by proper loading and balancing.
8. Convert to energy-efficient motors.

Plumbing

1. Reduce domestic hot water temperature.
2. Repair and maintain hot water and steam piping insulation.
3. Install flow restrictors.
4. Install faucets which automatically shut off water flow.
5. Decentralize hot water heating.
6. Add pipe insulation.

Laundry

1. Install heat reclamation system for laundry wash water.
2. Install heat reclamation system on dryers.
3. Install heat reclamation system on irons.
4. Install thermal fluid heated equipment.

TABLE S.4.1.1 (concluded)

<u>Kitchen</u>

1. Shut off range hood exhaust whenever possible.
2. Install high-efficiency steam control valves.
3. Shut off equipment and appliances whenever possible.
4. Install makeup air supply for exhaust.
5. Install heat reclamation system for exhaust heat.
6. Turn off lights in coolers.
7. Water heating heat pump.

<u>Miscellaneous</u>

1. Install incinerator and heat recovery system.
2. Install computerized energy monitoring and control system.

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* Reduce pumping flow
* Exhaust air heat recovery

Boiler Plant

* Install boiler combustion air trim system

Lighting

* Shut off lights when not needed
* Convert to energy-efficient systems

Electrical Equipment

* Install energy-efficient motors

Kitchen

* Install heat reclamation for kitchen hood exhaust

Miscellaneous

* Install computerized energy monitoring and control system (EMCS)

S.4.4 Dental Clinic

Lighting

* Delamping
* Energy Saving Fluorescent Lamps

Heating, Ventilating, and Air Conditioning

* Convert Dual-Duct Constant-Volume System to VAV

S.5 ECO FUNDING CLASSIFICATION

The ECOs recommended in this study fall into two major funding categories: those which can be implemented as no-cost/low-cost projects using the Fort's maintenance personnel and those which have been grouped to be funded through the Energy Conservation Investment Program (ECIP).

S.5.1 No-Cost/Low-Cost ECOs

These ECOs are characterized by requiring minimal or no capital investment, a quick return on any investment required, and immediate implementation by the facility engineer and hospital personnel. No-cost/low-cost ECOs are synonymous with operation, maintenance, and repair-type projects.

The following three no-cost/low-cost ECOs are recommended for immediate implementation.

R. W. Bliss Hospital

- Shutting Off Unused Lights
- Conversion of Interior Lighting to Higher Efficiency
- Reduction of the Outside Air Volume

Dental Clinic

- Delamping
- Conversion to Energy-Efficient Fluorescent Lamps

Table S.5.1.1 presents a summary of the cost, savings, and economics of each of these ECOs.

S.5.1.1 Shut Off Unused Lights

While the staff at the hospital is reasonably conscientious about turning off unused lights, certain areas of the hospital have been identified as candidates for new lighting control strategies. These strategies are: 1) install motion sensors in those areas which are intermittently or infrequently occupied, such as storage rooms and the dining room; and 2) install wall switch timers in those areas which are intermittently and briefly occupied, such as lavatories. Implementation costs are estimated at $1,798 for a savings of 42 MBtu/yr or $579/yr. This yields a simple payback period of 3.1 years and a savings-to-investment ratio (SIR) of 3.7.

S.5.1.2 Convert To Energy-Efficient Lighting Sources

It is recommended that all fluorescent fixtures in the hospital that use standard 4-ft, 40-watt lamps be relamped with energy saving nominal

TABLE S.5.1.1: RECOMMENDED NO-COST/LOW-COST ECOs

PROJECT DESCRIPTION	ECO IMPLEMENTATION SITE	COST ($)	ANNUAL ELECTRIC SAVINGS (MBTU/YR)	ANNUAL GAS SAVINGS (MBTU/YR)	ANNUAL DOLLAR SAVINGS ($)	SIR	SIMPLE PAYBACK (YR)
Delamping	D. Clinic	215	15.3	0.0	212	21.3	1.0
Reduce Outside Air Volume	Hospital	3,044	140.0	366.0	3,609	15.0	0.8
Conv. to Energy Saving Fluorescent Lamps	D. Clinic	295	28.2	0.0	390	11.5	0.8
Conv. Interior Lighting to Higher Eff.	Hospital	11,157	516.0	-244.0	6,006	5.9	1.9
Shutting-Off Unused Lights	Hospital	1,798	42.0		579	3.7	3.1
TOTALS		16,509	742	122	10,796		

34-watt lamps as the old lamps burn out. In addition, it is recommended that the incandescent fixtures which are currently fitted with 100-watt or less, medium-base incandescent lamps be refitted with energy-saving fluorescent lamps which are specifically designed for retrofit into these types of fixtures as existing lamps burn out. The implementation costs for energy-efficient fluorescent lamps are based on the differential cost of replacement for the various types of lamps in the building. The energy savings for this ECO were determined using the DOE2.1B building simulation program, which accounts for the interaction of lighting system modifications on HVAC energy use. With a total estimated cost of $11,157 and energy savings of 272 MBtu/yr or $6,006/yr, this ECO has a simple payback period of 1.9 years and an SIR of 5.9.

S.5.1.3 Reduce Outside Air Volumes

This ECM involves the reduction of outside air volumes to levels consistent with the Army Health Facility Design Manual recommendations. The reduction is accomplished through the adjustment of ventilation damper controls and exhaust fan speeds. Each zone of the hospital which was considered to be a candidate for this application was evaluated on a room-by-room basis with minimum outside air and exhaust quantities calculated according to the minimum air changes per hour criteria set forth in the design manual. The minimum outside air ratio was determined by comparing the maximum of the design manual exhaust or outside air cfm with what reductions could reasonably be achieved with existing systems.

Zones 3-1, 3-2, 4, 5, 6, 7-1, 7-2, 7-3, 9-1, 9-2, 9-3 and 10 are recommended for outside air volume reductions. The necessary changes at the air handling units consist of adjusting the automatic damper controls to obtain the required quantities. The corresponding reductions in exhaust air quantities, in order to maintain zone air balance, are accomplished by sheave changes at selected exhaust fans.

The energy savings resulting from this ECO were estimated at 506 MBtu/yr or $3,609/yr. The cost of adjusting dampers at the air handling units, making the sheave changes on the exhaust fans, and rebalancing is an estimated $3,044. This represents a simple payback of 0.8 years and an SIR of 15.0.

S.5.1.4 Delamping

The areas in the clinic which were substantially overlit at the time of the field audit and are candidates for delamping are: 23-Utility Work, 26-Conference/Lounge, 34-Office, 36-Office, 45-Office, 54-Admin. Office, 56-Secretary and 58-N.C.O.I.C. All of these areas have 4-ft by 2-ft, 4-lamp fluorescent fixtures. By disconnecting one of the two ballasts and removing the two lamps connected to this ballast, the input power requirements to the fixture are cut in half. This measure is recommended for implementation based on favorable SIR and payback.

S.5.2 Energy Conservation Investment Program (ECIP)

This section presents the group of ECOs that are being proposed as an ECIP project for implementation at R. W. Bliss Army Community Hospital. Each of the ECOs selected for packaging as an ECIP project complies with the investment, energy savings, and economic feasibility criteria outlined in the Energy Conservation Investment Program, governed by ECIP Guidance, dated 10 August 1982, and revised 18 January 1983. ECIP projects require a capital investment greater than $200,000 and must exhibit a Savings to Investment Ratio (SIR) greater than one. The project was packaged in accordance with DEH and hospital directives.

The project, tentatively titled "Hospital Energy Upgrade," is formed by the eight ECOs listed in Table S.5.2.1. This table contains a summary of the cost, savings, and life-cycle economics of each of the ECOs as well as of the total ECIP project. Each ECO is described in more detail below.

S.5.2.1 Convert Existing Constant Volume Dual-Duct Systems to Variable Air Volume

Dual-Duct Air Distribution Systems 1, 3, 4, 5, 6, 7, 8 and 9 were evaluated for conversion to variable air volume based on criteria found in Chapter 8 of the Army Health Facility design Manual. System 1, Surgery, and System 8, Obstetrics, were rejected for further consideration due to the requirement that sensitive or critical areas be served by constant-volume, double-duct, or terminal reheat systems. Each system was evaluated on a zone-by-zone basis as required by space use; each room of each zone was examined for minimum ventilation air requirements. The cost for the conversion is estimated at $166,298 with annual energy savings of 6,116 MBtu/yr or

TABLE S.5.2.1: RECOMMENDED ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

PROJECT DESCRIPTION	ECO IMPLEMENTATION SITE	COST ($)	ANNUAL ELECTRIC SAVINGS (MBTU/YR)	ANNUAL GAS SAVINGS (MBTU/YR)	ANNUAL DOLLAR SAVINGS ($)	SIR	SIMPLE PAYBACK (YR)
Heating Hot Wtr Variable Volume Pumping	Hospital	9,152	166.0	94.0	2,724	3.5	3.4
Boiler Combustion Oxigen Trim System	Hospital	26,709		991.6	4,230	3.4	6.3
VAV Conversion	Hospital	166,298	693.0	5423.0	34,453	2.8	4.8
Heat Reclamation in Kitchen Hood Exhaust	Hospital	17,836	35.6	386.3	2,264	1.7	7.9
Conv. to Energy Efficient Motors	Hospital	22,550	198.7		2,745	1.4	8.2
VAV Conversion	D. Clinic	21,532	139.0	85.9	2,315	1.3	9.3
HVAC Exhaust Heat Recovery AHU#8	Hospital	9,604	-8.1	208.0	844	1.3	11.4
Energy Monitoring and Control System	Hospital	455,566	1057.0	10781.0	64,068	1.2	7.1
TOTALS		729,247	2,281	17,970	113,643		

$34,453/yr. This makes for a simple payback period of 4.8 years and an SIR of 2.8.

S.5.2.2 Convert the Heating Hot Water Pump Flow to Variable Volume

The pumping plants were evaluated for the potential to reduce pumping flow with reduced load. The application of variable volume flow to the chilled water pumps was rejected due to control and operating conflicts with the chiller optimizer. However, the heating hot water plant currently operates 24 hours per day year-round and is thus a good candidate for variable volume control. This ECO involves the modification of the three-way hot-water control valves to operate as two-way valves and the installation of a variable frequency drive and controls to the hot water pumps. The energy and cost savings were estimated using DOD Engineering Weather Data for Fort Huachuca. The estimated cost of this ECO is $9,152 with savings of 260 MBtu/yr or $2,724/yr. This yields a simple payback of 3.4 years and an SIR of 3.5.

S.5.2.3 Install Combustion Air Trim Control System on Both Boilers

The two 200-horsepower, fire-tube, steam-forced draft boilers were evaluated for retrofit with combustion air trim control packages as a means of maximizing efficiency by controlling excess air. The proposed combustion air trim systems consist of an excess oxygen sensor located in the flue, a microprocessor-based electronic control unit, and an electro-mechanical actuator installed in the jackshaft linkage. The trim controller uses a signal received from the oxygen sensor, an input signal representing boiler load, and pre-programmed data on the desired excess air ratio at various boiler loads to establish an optimal excess oxygen setpoint. The trim controller then alters the position of the air damper via the actuator until the desired oxygen value is obtained. The implementation cost of this ECO is estimated at $26,709. The expected annual savings are 992 MBtu/yr or $4,230/yr. The simple payback period is 6.3 years with an SIR of 3.4.

S.5.2.4 Install Exhaust Heat Recovery in Air Handling Unit 8

The Obstetrics area air distribution system is currently operated on 100% outside air in accordance with health facility regulations. The feasibility of recovering heat by using a run-around heat recovery coil loop

was explored and is recommended. The implementation of the concept involves the installation of coils in the main exhaust and outside air intake ducts at the air handling unit. The cost for this retrofit is estimated at $9,604 with savings of 200 MBtu/yr or $844/yr. The simple payback period is 11.4 years and the SIR is 1.3.

S.5.2.5 Install Exhaust Heat Recovery in the Kitchen Hood

The kitchen ventilation system was evaluated for the potential of waste heat recovery from the hood exhaust air. The recovered heat would be used to pre-heat or pre-cool the outside air at the make-up air unit using a run-around coil loop. The implementation cost is estimated at $17,836 with savings of 422 MBtu/yr or $2,264/yr. The simple payback period is 7.9 years and the SIR is 1.7.

S.5.2.6 Replace All Electric Motors Larger Than Three Horsepower With Energy-Efficient Motors

All of the electric motors greater than three horsepower were evaluated for replacement with high-efficiency motors. These motors are located throughout the hospital in AHUs 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, Return Fans 7 and 9, chilled water pumps, heating hot water pumps, cooling tower fan, and kitchen exhaust fan. The implementation cost of this ECO is $22,550, with savings of 199 MBtu/yr or $2,745/yr. The simple payback period is 8.2 years and the SIR is 1.4.

S.5.2.7 Install Energy Monitoring and Control System

The feasibility of installing an independent EMCS system for the monitoring and control of the mechanical and electrical systems at the hospital was established. While all equipment monitoring and control functions are to be performed at the hospital, remote monitoring will be provided at the Fort's central EMCS office at Greely Hall.

The EMCS provides a central point of operator monitoring and control of certain hospital HVAC systems. This enables the implementation of certain energy conservation program applications to effect energy savings in the controlled systems. Monitoring functions for security and fire and safety were also incorporated.

The installation of the EMCS requires a capital investment of $455,566 and will effect energy estimated at 11,838 MBtu/yr or $64,068/yr. The simple payback period is 7.1 years and the SIR is 1.2. The cost estimate was based on the most recent U.S. Army Corps of Engineers "EMCS Cost Estimating Guidelines," February 1983. Given the rapid reduction in costs of EMCS hardware and software, current costs are in general much lower than those contained in said guidelines. It can be safely assumed that when the final design stage of the project is reached, the same capabilities proposed will be procured at a much lower cost.

S.5.2.8 Convert the Constant Volume, Dual-Duct System to VAV

The dual-duct HVAC system was considered for the potential for conversion to variable-air-volume (VAV). While conversion of dual-duct systems whose cooling source is chilled water to VAV is well established practice, the cooling source for the dental clinic is a direct expansion system with an air-cooled condensing unit. As such, it is necessary to add additional capacity control equipment to the condensing unit in the form of a hot gas bypass system in order to avoid coil freeze-up problems and potential damage to the cooling coils. The other modifications to the system involve the addition of retrofit VAV units to the hot and cold ducts leading to each mixing box marked with an "HC" on the worksheet on page 0-41, the addition of inlet vanes to the supply and return fans and static pressure controls to control the inlet vanes.

Each room of the clinic was evaluated for minimum air ventilation requirements according to the design conditions in Table 8-1 of the Army Design Manual. A tabular compilation of this analysis, as well as recommendations for the type of conversion required for each dual-duct box, is presented on pages 0-40 through 0-43. Since the clinic is a single-story structure and all zones are exposed to the roof, all boxes are required to have both heating and cooling capacity, including those serving the interior zones. Those boxes which have one or more outlets serving common areas from which general exhaust make up air is drawn were not indicated for modification. This measure is recommended for implementation based on a favorable SIR.

S.5.3 Operational Recommendations

S.5.3.1 Air Distribution Systems

Filters and fan belts of supply and return fans are checked every other day without cowlings. Exhaust fans are not inspected regularly. Air handling unit filters are changed every three months or as determined by visual inspection. The inclined manometer type differential pressure gages are installed in the AHUs but none were in operation. Either they were dry (required gage oil) or they were blocked at one or both ends. Automatic Temperature Controls (ATCs) are not maintained in any regular fashion. The ATCs are in urgent need of calibration.

The cold-deck temperatures of all AHUs were measured and some were found very far from the design temperatures. In AHU Nos. 1 and 5, the OSA damper was closed. The maintenance staff member contacted explained that the linkages had to be removed due to burned solenoids. In AHU No. 7, the economizer controls were found disconnected at the OSA damper.

Broken fan belts were found on a large number of exhaust fans. Complaints of "stuffiness" were reported in the area served by the fan. Pressure differentials were measured across supply and return fans whenever possible. Negative pressure differentials were measured across the return fans of System Nos. 2, 3, 6 and 7. The reason for this has not yet been determined.

S.5.3.2 Boilers

There are two identical steam boilers at R. W. Bliss Army Hospital. One of them is operated for six months of the year while the other one is in cold shutdown. At switchover time, the "cold" boiler is tuned and tested before the on-line boiler is shut down. In the existing combustion controls, the air-to-fuel ratio (AFR) can be set at 12 different partial loads by a 12-point adjustable cam. During the switchover "tune-up," the AFR is set at "high" and "low" fire by visually observing the color of the flame. After this is done, flue gas samples are taken and analyzed remotely. During the audit, flue gas analysis was performed on both boilers, and it was determined that the excess air could be substantially reduced thus improving the combustion efficiency of the boilers. See Boiler Oxygen

Trim Control ECO description for the results of said test. Also at switchover time, the relieved boiler is inspected for scale and its regulators and controls tested and overhauled, if necessary. The results of the inspections performed on both boilers on 5-28-85 are included in Appendix J.

Boiler water analysis consists of checking Hydroxide (not to go over 200 PPM), Phosphate (to hold at 45 PPM), Sodium Sulfite (not to range over 30 PPM), total dissolved solids using Myron L type meter (2500-3500 PPM), and Tannin Color (Range 3M-3D). The pH is also taken and held at a range of 11-12. After boiler water analysis, the boiler is bottom blowed, if necessary, to hold solids; then chemicals, such as Tannin, Phosphate, Sodium Sulfite with Morpholine, are added to the condensate return. Boiler water samples are taken early every day of the week except weekends. At the time of the test, no blowdown had been required for the previous three weeks.

S.5.3.3 Chillers

The chiller condensers are visually inspected once a year. No thermal performance tests are used to determine fouling factors. According to maintenance personnel, head pressure is the only fouling indicator used. Water chemistry tests and control are coordinated by the Calgon distributor under government contract. Weekly inspections and water tests by Calgon are followed by monthly reports which are sent to the Fort FED.

Water treatment at the present time consists of the use of an inhibitor and scale remover and an algaecide. The inhibitor is added continuously into the condenser water loop by means of a Total Dissolved Solids (TDS) controlled metering pump. The algaecide is added in a batch form only when determined by water tests. The post maintenance staff seemed to be satisfied by the results obtained by the above procedure.

S.5.3.4 Lighting Systems

Current maintenance of lighting systems seem to be adequate. A hospital is a low-dust environment so dust accumulation on luminaire reflective surfaces and lenses occur rather slowly. However, it is recommended that whenever lamps are replaced, both reflective surfaces and diffuser lenses be cleaned with a damp cloth to remove the dust without scratching. If

excessive yellowing or darkening of the lenses is noticed, these should be immediately replaced.

S.6 ENERGY AND COST SAVINGS

If all the recommended no-cost/low-cost projects at the Hospital and Dental Clinic are implemented, annual electric energy savings of 217,404 kWh (742.0 MBtu) and 122.0 MBtu of natural gas can be expected. At the rates found in Appendix A of the main body of this report, this is equivalent to $10,796/yr.

If all ECIP projects proposed for the Hospital and Dental Clinic are implemented, annual electric energy savings of 668,327 kWh (2,281 MBtu) and 17,883 MBtu of natural gas can be expected. This is equivalent to a total savings of $113,643/yr.

Another way of visualizing the impact of implementing the above projects is by the percent reduction of energy use with respect to present use. These reductions, as well as total dollars, are presented below for electrical and natural gas energy at the Hospital only. The no-cost/low-cost project implementation would reduce the electrical energy consumption by 7.4% and the natural gas use by 0.4%. The ECIP project implementation would reduce electrical energy consumption by 22.8% and natural gas by 65.4%.

Currently, the hospital annually consumes an estimated 2,756,988 kWh (9,409.6 MBtu) at a cost of $130,333 and 27,357.8 MBtu of natural gas at a cost of $125,539. The current total annual energy cost to the hospital is estimated at $255,872.

If all recommended projects for the Hospital were implemented, electrical energy requirements could be reduced to 1,924,817 kWh (6,569.4 MBtu) and gas consumption reduced to 9,351.9 MBtu. The total dollar reduction, if all recommended projects were implemented, would be $121,965/yr, reducing the energy cost from a current $255,872/yr to a projected $133,907/yr. This is equivalent to an energy cost reduction of 47.7%.

S.6.1 Total Potential Energy Savings

The total potential energy savings for the Hospital and Dental Clinic are summarized in Table S.6.1.1.

TABLE S.6.1.1: RECOMMENDED ECO SUMMARY FOR R.W. BLISS ARMY HOSPITAL AND DENTAL CLINIC

PROJECT DESCRIPTION	ECO IMPLEMENTATION SITE	ECO FUNDING CLASSIFICATION	COST ($)	ANNUAL ELECTRIC SAVINGS (MBTU/YR)	ANNUAL GAS SAVINGS (MBTU/YR)	ANNUAL DOLLAR SAVINGS ($)	SIR	SIMPLE PAYBACK (YR)
Delamping	D. Clinic	No Cost/Low Cost	215	15.3	0.0	212	21.3	1.0
Reduce Outside Air Volume	Hospital	No Cost/Low Cost	3,044	140.0	366.0	3,609	15.0	0.8
Conv. to Energy Saving Fluorescent Lamps	D. Clinic	No Cost/Low Cost	295	28.2	0.0	390	11.5	0.8
Conv. Interior Lighting to Higher Eff.	Hospital	No Cost/Low Cost	11,157	516.0	-244.0	6,006	5.9	1.9
Shutting-Off Unused Lights	Hospital	No Cost/Low Cost	1,798	42.0		579	3.7	3.1
Heating Hot Wtr Variable Volume Pumping	Hospital	ECIP	9,152	166.0	94.0	2,724	3.5	3.4
Boiler Combustion Oxigen Trim System	Hospital	ECIP	26,709		991.6	4,230	3.4	6.3
VAV Conversion	Hospital	ECIP	166,298	693.0	5423.0	34,453	2.8	4.8
Heat Reclamation in Kitchen Hood Exhaust	Hospital	ECIP	17,836	35.6	386.3	2,264	1.7	7.9
Conv. to Energy Efficient Motors	Hospital	ECIP	22,550	198.7		2,745	1.4	8.2
VAV Conversion	D. Clinic	ECIP	21,532	139.0	85.9	2,315	1.3	9.3
HVAC Exhaust Heat Recovery AHU#8	Hospital	ECIP	9,604	-8.1	208.0	844	1.3	11.4
Energy Monitoring and Control System	Hospital	ECIP	455,566	1057.0	10781.0	64,068	1.2	7.1
TOTALS		No Cost/Low Cost	16,509	742	122	10,796		
		ECIP	729,247	2,281	17,970	113,643		

S.7 ENERGY PLAN

The implementation schedule of the different projects is summarized in Table S.7.1. All recommended ECOs are listed individually. All those marked ECIP have been grouped in one single ECIP project for funding purposes. The energy plan calls for the implementation of all no-cost/low-cost projects in FY 1988, while the ECIP project is to be implemented during FY 1989. Included in Table S.7.1 are the projects' implementation costs, annual energy savings, annual dollar savings, SIR, simple payback, and implementation year.

The results in Table S.7.1 are shown graphically in Figure S.7.1. The impact on current energy consumption of the two project categories, no-cost/low-cost and ECIP, are displayed over a ten-year period in relation to their programmed year.

Figure S.7.1 shows that starting in 1988, the no-cost/low-cost projects will reduce total annual energy consumption 4.2%. In 1989, the implementation of the ECIP project will result in an additional reduction of the current annual energy consumption. Thus in 1989, after implementation of all recommended projects, the energy consumption will be 45.3% of that currently used. The effect of this energy reduction on hospital energy costs along, will reduce the current energy expense from an estimated $255,872/yr to $133,907/yr. This cost assumes unchanging fuel costs for the period of analysis.

TABLE S.7.1: FUNDING AND IMPLEMENTATION SUMMARY FOR E.E.A.P. PROJECTS AT R.W. BLISS HOSPITAL AND DENTAL CLINIC

PROJECT DESCRIPTION	ECO IMPLEMENTATION SITE	ECO FUNDING CLASSIFICATION	COST ($)	ANNUAL ELECTRIC SAVINGS (MBTU/YR)	ANNUAL GAS SAVINGS (MBTU/YR)	ANNUAL DOLLAR SAVINGS ($)	SIR	SIMPLE PAYBACK (YR)	IMPLEMENTATION DATE (FISCAL YEAR)
Delamping	D. Clinic	No Cost/Low Cost	215	15.3	0.0	212	21.3	1.0	1988
Reduce Outside Air Volume	Hospital	No Cost/Low Cost	3,044	140.0	366.0	3,609	15.0	0.8	1988
Conv. to Energy Saving Fluorescent Lamps	D. Clinic	No Cost/Low Cost	295	28.2	0.0	390	11.5	0.8	1988
Conv. Interior Lighting to Higher Eff.	Hospital	No Cost/Low Cost	11,157	516.0	-244.0	6,006	5.9	1.9	1988
Shutting-Off Unused Lights	Hospital	No Cost/Low Cost	1,798	42.0		579	3.7	3.1	1988
Heating Hot Wtr Variable Volume Pumping	Hospital	ECIP	9,152	166.0	94.0	2,724	3.5	3.4	1989
Boiler Combustion Oxigen Trim System	Hospital	ECIP	26,709		991.6	4,230	3.4	6.3	1989
VAV Conversion	Hospital	ECIP	166,298	693.0	5423.0	34,453	2.8	4.8	1989
Heat Reclamation in Kitchen Hood Exhaust	Hospital	ECIP	17,836	35.6	386.3	2,264	1.7	7.9	1989
Conv. to Energy Efficient Motors	Hospital	ECIP	22,550	198.7		2,745	1.4	8.2	1989
VAV Conversion	D. Clinic	ECIP	21,532	139.0	85.9	2,315	1.3	9.3	1989
HVAC Exhaust Heat Recovery AHU#8	Hospital	ECIP	9,604	-8.1	208.0	844	1.3	11.4	1989
Energy Monitoring and Control System	Hospital	ECIP	455,566	1057.0	10781.0	64,068	1.2	7.1	1989
TOTALS		No Cost/Low Cost	16,509	742	122	10,796			
		ECIP	729,247	2,281	17,970	113,643			

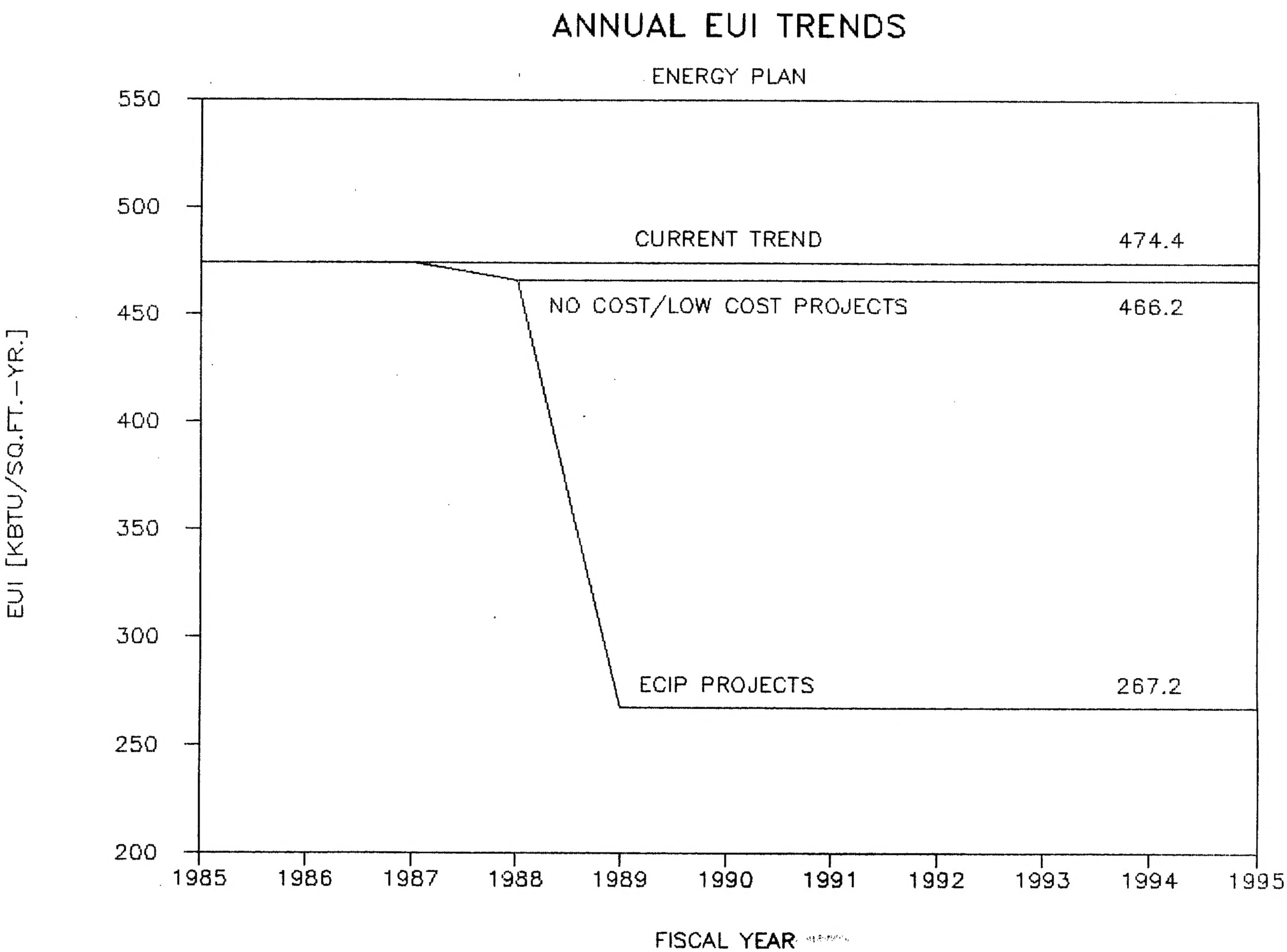
ANNUAL EUI TRENDS
ENERGY PLAN
CURRENT TREND
474.4
NO COST/LOW COST PROJECTS
466.2
ECIP PROJECTS
267.2
EUI [KBTU/SQ.FT.-YR.]
550
500
450
400
350
300
250
200
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
FISCAL YEAR

Figure S.7.1